Chapter 1
RETROSPECTIVE ANALYSIS OF THE IMPROVEMENT OF DESIGN ELEMENTS OF CARTRIDGES (AMMUNITION) FOR HAND-HELD SMALL ARMS, GENESIS AND DEVELOPMENT OF SCIENTIFIC IDEAS ABOUT THEIR FORENSIC RESEARCH

The issues related to the expert study of cartridges (ammunition) used for firing modern small-arms firearms, it is important to consider first of all in the historical aspect, taking into account that "… the scientific study of phenomena and processes cannot limit itself to their state at the moment of 'available' existence, since the causal relationship in the historical development will be lost" [88, p. 110].

S. N. Tregubov in 1912 pointed out that "colossal advances in technology…, enriching modern humanity with various inventions, discoveries and improvements…, at the same time, they had a noticeable but, unfortunately, harmful effect on the external manifestations of crime…" and "rapid-fire weapons and smokeless gunpowder…, advances in chemistry, bacteriology, etc. — all this, along with the benefits brought to humanity, contributes to the refinement of the execution of criminal plans and the elusiveness of the perpetrators" [263, p. 7].

As noted by V. A. Ruchkin, "… the design and combat characteristics of the weapon are largely determined by the linear-weight, structural and other features of the cartridge" [227]. For design patrons (ammunition), used for called the shots from manual rifle firearms, with moment their the emergence of until now time characteristically a permanent improving, associated in including with historical development manual rifle firearms in a whole with perspective raising his efficiency and reliability functioning.

The study of the process of creating and improving the design of cartridges (ammunition) used for shooting from small arms, their impact on the practice of forensic research should be carried out taking into account the historical development of both their design as a whole and its individual elements, since the identification of objective patterns should be due to an adequate reflection of reality, disclosure of the essence of the studied reality, explanation of facts, phenomena and processes. Based on the integrative-historical approach and historical methods

of research of most of the studied phenomena, it is possible to conduct specialized research in depth due to a more reasonable interpretation of the results.

Thus, in the study of the problem of forensic investigation of cartridges (ammunition) used for shooting from small arms, it seems reasonable to consider not only the historical aspect of the origin and development of forensic ballistic examination of these objects, but also the evolution of their design from the point of view of military and technical science.

The most important factor that influenced the evolution of cartridges (ammunition) and small arms as a whole as an object of material culture is the invention of gunpowder — the first propellant explosive, which later became an integral element of the design of cartridges (ammunition). With the invention of gunpowder to replace cold and throwing weapons, using the muscular power of man, came firearms, using the energy of gunpowder gases, which had a number of previously unattainable properties and qualities, the main of which-increasing the range of fire and the striking ability of the wounding projectile. Analysis of historical sources shows that the original improvement of firearms was due to the needs of its use in the military. According to historians, gunpowder invented in the IXth century in China, and then spread to Europe and Asia. By the end of the XIIIth century the first artillery guns were constructed in China [87, p. 13].

In the lands corresponding to the territories of modern Belarus and Russia, firearms appeared almost simultaneously — in the 80th of the XIV century. So, in 1383 it was used by the army of the Grand Duchy of Lithuania during the siege of Trok castle [26, p. 213]. In the chronicle sources indicate that during the campaign of Prince Vytautas with the crusaders on Vilna in 1391 "many Lithuanians and Germans beaten by cannons" [209, pp. 125–126]. In 1393 Prince Vytautas used cannons in the siege of Vitebsk, occupied by the rebellious Prince Svidrigaila [209, p. 235].

The first mention of the use of firearms in the Moscow state during the siege of Moscow by the Tatars dates back to 1382, when Khan Tokhtamysh with a large army besieged Moscow. The townspeople three days successfully repelled the attack of the Horde with the use of light cannons ("pallets") and, obviously, cannons of a larger caliber. "When the Tatars approached the walls of the city, then the inhabitants of the city, resisted them, shot arrows and stones, the allies helped in the

defense of pallets, crossbows, resembling harquebuses, as well as large cannons" [210, p. 130].

Manual small arms firearms appeared as a result of the evolutionary development of artillery weapons, in particular cannons. Initially the barrels of guns and rifles were made of wood, because the technology of making them out of metal was not yet finalized. So, in 1596, a wooden gun was used in the battle of Gulsen (Holland), in 1624, a mortar made of a wooden stump was fired at the city of Cleves [182, p. 50].

In the initial period, muzzle-loading hand-held small arms had a low rate of fire, and the kinetic energy of bullets corresponded to the energy of arrows fired from a crossbow, due to the small amount of obturation (i. e., ensuring the sealing of the barrel of firearms when fired, preventing the breakthrough of powder gases) between the bullet and the walls of the barrel. To eliminate this disadvantage, after filling the gunpowder in the barrel channel, a wad made of tow, leather, bast or other soft materials was placed on it, then a bullet was sent to the barrel channel by blows of the ramrod [55, pp. 60–62].

To increase the rate of fire of small arms in 1530 in Spain, a paper cartridge was invented, consisting of a paper sleeve, a powder charge and a bullet. This increased the convenience of loading, since the mass of the powder charge was pre-selected to the gun, provided its protection from external influences (moisture), and the shell of the cartridge was used as wad. This innovation has significantly increased the rate of fire of small arms, which subsequently led to the spread of paper cartridge throughout Europe [157, p. 44]. In particular, in Russia, in the ammunition of Ivan The Terrible Sagittarius army to increase the rate of fire and ease of loading appeared zaryadtsy (cushions with a powder charge), similar in functional purpose to a paper cartridge [154].

Initially, all samples of firearms were loaded from the muzzle of the barrel, but already in the XIV–XVI centuries. Attempts were made to load from the breech of the barrel. Breech-loading small firearms consisted of a barrel and a separate charging chamber that is inserted into the barrel and secured by a special wedge, but in this period, this loading system have not been spread because of imperfection of technology of locking node and the dangers of breakthrough powder gases in the shooter's direction [271, p. 12].

In order to facilitate the loading of hand-held small arms from the muzzle of the barrel since 1498, rifling (initially straight) began to be

made to embody the idea of the Austrian gunsmith Gaspar Zollner. Various constructive ideas, perceived and in modern designs manual rifle firearms, originated in the XVI century. Thus, in the works of Leonardo da Vinci (1500), Lorini (1579) contained drawings and sketches of the outer surface of the barrels equipped with piston and wedge gates and had a helical thread to ensure the stability of the flight of oblong projectiles, but the spread of these structures inhibited as the General state of technology, and the difficulties associated with the need for precise machining and low level of development of metallurgy [286, p. 13].

With the advent of screw rifling, the firing range of hand-held small arms increased to 600 steps by giving the bullet gyroscopic stability as a result of rotation, increased accuracy, accuracy and accuracy of the trajectory. However, the inconvenience of loading did not allow widespread use of such weapons. The situation changed dramatically only by the end of the XIX century after the transition to charging from the outer surface of the barrel and the invention of the unitary cartridge [157, pp. 37–38].

The transition from a muzzle-loading hand-held small-arms firearm to a breech-loading barrel and the creation of a unitary cartridge with a metal sleeve was made possible by the discovery of initiating explosives, as well as the replacement of smokeless powder with smokeless. The inventor of the initiating explosive, mercury fulminate, is not known for certain ($Hg(CNO)_2$), but the first mention of it are found in literary sources of the beginning of the XV century, in particular in the "Book on pyrotechnics" (Feuerwerksbuch). In the manuscript of Basil Valentine (Basilius Valentinus), dating from the first half of the XVII century, also contains a mention of "rattling gold", discovered by the Dutchman Cornelius van Drebbel. The first presentation of the process of manufacturing mercury fulminate belongs to the German chemist I. Kunkel (1690). Attempts to invent friction and shock initiating explosives were made by the French scientist P. Bolduc (1700). The capsule in an iron cap with mercury fulminate of the open type is invented by the American D. Shaw in 1814 [55, pp. 163–164].

By the beginning of the XVIII century. with the advent of gremuchertutnogo capsule-igniter, the idea of creating a so-called unitary PA-throne (from lat. unitas-unity), the design of which allowed using the sleeve to combine the charge, the projectile and the primer-igniter. In 1812, the French gunsmith S. I. Poly patented a the outer surface of

the barrels rifle and a unitary cartridge, the sleeve of which was made of metal on a lathe; in 1814 he also invented a cartridge, the initiating composition of which was ignited by compressed air [157, p. 137]. However, the proliferation of these structures of ammo and small firearms is not received.

By 1829, the German gunsmith I. N. Dreise invented a unitary cartridge with a paper sleeve for a needle rifle of his own design. As a result of the shift from loading of the cartridge from the barrel to the principle of loading from the breech and use the unit lock the sliding bolt from turning was provided an acceptable level of obturation. In 1840 the needle gun of the Dreise system under a unitary cartridge with a paper sleeve was adopted in Prussia, in 1868 the needle gun of the Carle system was adopted in Russia. However, in the 70s of the XIX century. This sample was replaced by systems using a unitary cartridge having a metal sleeve, the design of which is close to modern [39, p. 319].

In 1842, the French gunsmith L. Flaubert invented a unitary hornless cartridge with a solid copper sleeve, improved in 1856 by B. Beringer by placing a charge of gunpowder in it [157, p. 139] (note that the cartridge (ammunition) of this design (.22 Long Rifle) is used without any changes up to the present time in sports and hunting rifled firearms).

English gunsmith C. Lancaster in 1852 invented a new design of the cartridge, in which the ignition of the powder charge in the sleeve was carried out through the seed holes. The introduction of in pillar patron a metal thimbles contributed to the final addressing problems breakthrough gunpowder gases under loading with breech parts of trunk and transition to designing mnogozaryadnykh weapons systems, in particular create rifles with longitudinally-sliding the bolt. This, in turn, led to the abandonment of muzzle-loading hand-held small arms and the reduction of the barrel caliber to 11–13 mm [202, pp. 7–8].

During this period attempts were made to improve the combat characteristics of handguns with rifled bore and ease of loading by changing the shape of the bullet. In the transition to weapons with rifled barrel on the surface of the bullets, which originally had a spherical shape, began to make projections, repeating the elements of the cross-section profile of the barrel. In 1846, the British General W. Jacobs proposed an oblong bullet with four leading protrusions, which increased the range of fire and piercing effect of bullets of hand-held small firearms [55, p. 195]. In 1864, the Englishman J. Whitford, having conducted a series of experi-

ments related to the study of the effect of rifling the barrel and the shape of the bullet on the results of shooting, received a patent for a hexagonal bullet oblong shape of its own design. The accuracy of the specified type of bullets at a range of 450 m was 7.7–10.7 cm from the center, while the best result for this distance at the time was 64 cm [55, pp. 200–201]. This served as the basis for the development of new types of bullets for hand-held small arms (cylindrical (oval), pointed and blunt-pointed forms). By 1860, Austria had developed bullets for 13.9-millimeter guns that contained explosives [55, pp. 207–208]. Besides, cartridges with a buckshot shell, incendiary bullets with a pyrotechnic mix which at hit in a body were destroyed were created and caused extensive damages (in 1868 their use against the person is forbidden by the international agreement "about cancellation of the use of explosive and incendiary bullets" concluded in St. Petersburg) [211, p. 34].

In the period under review as the main means of ignition of the powder charge in the cartridge was used gremuchertutny capsule. However, in 1870 in France, an "electric" gun was invented, in which the ignition of the powder charge was carried out by an electric method from a galvanic battery placed in the butt of the gun; later, the Belgian gunsmith G. Pipper created a gun of a different system, used as a hunting gun [157, p. 281]. Currently, this method of ignition has found application in the design of the cartridge (ammunition) 4,7×33, used for shooting from an automatic rifle Heckler & Koch G11 [56, pp. 193–210], and also cartridges (ammunition) 18×55T to firearms of traumatic action [199; 297], individual designs of homemade hand-held small firearms [155].

Until the middle of the XVIII century. the main type of gunpowder remained smoky. M. V. Lomonosov made a significant contribution to the production of gunpowder in Russia. After a series of experiments with different compositions of gunpowder, he chose the most optimal ratio of the components of the powder mixture-potassium nitrate, charcoal and sulfur, which remains unchanged to the present time. The result of these experiments were also scientific works of the scientist —"Thesis on the birth and nature of saltpetre" and "On the nature of gunpowder". The main problem of production of large volumes of gunpowder was the lack of potassium nitrate, attempts to replace it in the composition of gunpowder with other substances were not successful [249].

At the end of the XIX century, pyroxylin (cellulose nitrate) was proposed to replace smoky gunpowder, which has a number of significant

drawbacks. however, being a powerful explosive, it could not be used as a propellant charge in its pure form. French engineer P. Weil in 1884 plasticized nitrocellulose in a mixture of alcohol and ether, as a result of which smokeless gunpowder was invented. Depending on the plasticizer used, different grades of smokeless gunpowder with certain properties are obtained [292, p. 273].

In Russia experiments with pyroxylin were carried out in 1845 by the artilleryman A. A. Fadeev. However, the unstable properties of the resulting pyroxylin during storage (in particular, self-ignition) and the combustion close to explosion in the barrel channel of small arms firearms did not allow it to be used as a propellant explosive Burning [55, pp. 375–376].

In connection with the adoption of the French troops in 1886 of the Lebel rifle in Russia, work on the production of domestic smokeless gunpowder was intensified with the participation of scientists, including D. I. Mendeleev [150], who noted: "Smoky gunpowder was found by the Chinese and monks-almost by accident, by touch, by mechanical mixing, in the scientific darkness. Smokeless gunpowder is discovered in the full light of modern chemical knowledge" [160, p. 47].

G. A. Zabudsky, Z. V. Kalachev, S. V. Panpushko, A.V. Sukhinsky, N. P. Fedorov also made a significant contribution to the production of smokeless gunpowder in Russia. The high level of secrecy at the French plants did not allow to establish the necessary technological reagents; at the Vetturen plant in Belgium, A.V. Sukhinsky literally "by smell" determined the use of ethyl acetate in its production [278].

By the early twentieth century. in the world was established the production of several types of smokeless gunpowder, of which the most common were pyrocollodium powder D. I. Mendeleev, pyroxylin powder P. Viel, as well as powder mixture-cordite.

The use of smokeless gunpowder in the design of cartridges (ammunition) would be impossible without appropriate scientific justification and means of measuring the internal and external ballistic parameters of the shot. If initially rules and receptions waging called the shots from ancient throwing machines were based on results, forestry by practical experiences, then to mid-the eighteenth digits thanks to scientific writings J. L. Lagrange, I. Newton, B. Robins and L. Euler in ballistics have become be used achievements mathematics, physics and chemistry.

The analysis of literary sources testifies that at the end of XIX — the beginning of XX century the design of cartridges of manual small arms firearms was based on the requirements theoretically proved by military science to such ammunition. As noted above, this was due to the progressive development of scientific and technological progress, primarily in the field of natural Sciences.

For mass weaponry army needed unified samples manual rifle firearms, with a certain stability such characteristics, as ensuring monotonous speed by air bullets, constancy properties gunpowder weapons and others. It is the need to comply with these conditions that led to the active use of the achievements of natural Sciences in the development of samples of hand-held small arms. The principles of research of parameters of manual small arms, methods of production of measurements, originally developed within the framework of classical mechanics, supplemented by scientists in the field of military Sciences, subsequently began to be applied in forensic activities.

The idea of transforming the motion of a small projectile with high velocity into the motion of a body with high mass but low velocity was used in the study of bullet motion by the French astronomer J. Cassini in 1707 [68, p. 42]. In 1740, B. Robbins created a ballistic pendulum, which made it possible to more reliably determine the initial velocity of bullets fired from small-hand firearms. L. Euler, developing the ideas of I. Newton and B. Robins, in the works "New Foundations of Artillery" "On the Power of Gunpowder", "On the Impact of Bullets When Firing on the Board" attempted to scientifically substantiate empirical data in the field of ballistics [294], J.-L. Lagrange in the work "Analytical Mechanics" completed the mathematization and generalized the empirical material accumulated by this time in classical mechanics, which contributed to the use of this area of knowledge in ballistic research.

The development of ideas about the internal and external ballistics of hand-held small arms, the emergence of new measuring instruments allowed to determine with the necessary accuracy the internal and external ballistic parameters of the shot. In more detail the development of tools and methods of expert measurements will be discussed in section 3.2 of the monography.

The Russian school of experimental ballistics was founded by N. V. Mayevsky, who in his work "On the Influence of Rotational Motion on the Flight of Oblong Projectiles in the Air" (1865) determined

the directions of its further development. N. A. Zabudsky for the first time in the world theoretically justified the method of calculating the steepness of rifling required to ensure the stability of a rotating bullet in the air. The primacy in the use of electricity to measure the speed of projectiles and bullets belongs to K. I. Konstantinov, who in 1842 invented the electric chronoscope, in 1843 — electromagnetic pendulum chronograph, in 1844 — electroballistic chronograph [290, pp. 12–22].

These achievements in the production of measurements of ballistic processes occurring when fired, allowed not only to move to the use of smokeless gunpowder as a propellant charge used in the design of ammunition cartridges, but also to provide scientific justification for other parameters of hand-held small arms in its design and application to the target.

The lower rate of combustion of smokeless powder compared to smoky, as already indicated, allowed to achieve a higher bullet velocity with a smaller mass of powder charge. However, at the same time, the lead bullet, acquiring a greater speed in the barrel channel, received a significant deformation in the process of firing. The solution to this problem was the appearance of shell-type bullets, in which the lead core is enclosed in a shell of copper or Nickel silver, which performed the function of "solid" lubrication, which led to a decrease in the caliber of firearms to 7–9 mm, as well as the appearance of multi-loading and automatic hand-held firearms [202, p. 9].

As a result of ballistic studies and scientific research by scientists in Germany (A. Gleinich), Russia (G. P. Kisnemsky), France (Desalle) since the early 90th of the XIX century. the armies of these countries began to accept rifle cartridges with a pointed shell bullet [20, pp. 3–33; 55, pp. 465–538]. The Russian cartridge of 7.62×54R caliber to Mosin rifle, the German cartridge of 7.92×57 caliber to Mauser rifle, the French cartridge of 8×50R caliber to Lebel rifle were the most technically perfect samples in the considered period, as they embodied the most advanced scientific achievements at that time [55, pp. 467–534; 272, pp. 142–144].

With 50th nineteenth digits gained development korotkostvolnoe manual small arms firearms — automatic pistols and revolvers, for called the shots from which have become be applied unitary bullets. Unified models of pistol cartridges at that time did not exist, so the designers pistols were designed for these cartridges yourself. French gunsmith K. Le-

foche in 1836 invented a revolver for a spire unitary cartridge of his own design [204]. This cartridge originally had no protruding flange (edges) and was fixed in the chamber stud. The flange of the sleeve it appeared later under the influence of Chuck design L. Flaubert.

In 1860, the English gun designer C. Lancaster, using the ideas of the designs of cartridges K. Lefoche (folder casing, metal pallet) and L. Flaubert (flange), developed a breech-loading hunting rifle under the cartridge of its own design (a prototype of the hunting cartridge used in modern smoothbore hunting weapons) [55, p. 297, 305; 157, p. 137; 218, pp. 134–150].

Belgian gunsmith L. Nagan, using a revolver cartridge and the development of his compatriot G. Piper, designed a revolver, which in 1895 was adopted in the Russian army [171, p. 11].

German design engineer H. borchardt in 1893 and the brothers Federle in 1895 proposed the first successful design of automatic pistols for unitary cartridges of their own design. The modified design of the unitary cartridge of H. borchardt was later used by the German designer G. Luger in the creation of a 9×19 caliber cartridge and an automatic pistol R-08 "Parabellum" [75, p. 23; 172].

Thus, the analysis of scientific literature on the history and improvement of small firearms, ammunition (ammo) to it shows that at the beginning of the XIX century was designed quite perfect samples of small firearms for firing using a unitary cartridge.

In further implemented technical upgrading the as design patron in a whole, so and individual his elements: invention smokeless gunpowder, the creation new species design thimbles and bullets, reducing caliber and raising rate of fire weapons. This trend continued until the end of the XX century. A. A. Blagonravov said: "the history of the development of any branch of engineering gives us countless examples of first, as new advances in technology summarize the huge experience of the previous stages of development, reflect and Refine previous achievements on a new technical basis, second, on the new basis back, seemingly exhausted and obsolete shape and design, in reality, the newly fertilized dialectical process of development of various aspects of technology" [158, p. 3].

Taking into account the above and based on the information given in the works of A. A. Blagonravov, V. E. Markevich, V. G. Fedorov, M. M. Blum, V. N. Dvoryaninov, V. A. Ruchkin and other scientists,

it can be concluded that the improvement of hand-held small arms and ammunition used in it from the moment of invention to the end of the XIX century is a continuous progressive process consisting of the following stages:

the invention of firearms, which uses the principle of expanding gases produced by the combustion of a propellant charge;

transition from a muzzle-loading hand-held small-arms firearm to a breech-loading one;

the creation of a unitary cartridge, which led to an increase in the rate of fire of hand-held small firearms;

the invention of smokeless powder that improve the speed of a bullet when fired and thus increase the lethality, range and accuracy of fire, flatness of trajectory;

the use of certain laws of rational layout of the design elements of cartridges(ammunition), parts and mechanisms of hand-held small firearms;

the use of a rifled barrel in hand-held small arms, providing gyroscopic stabilization of the bullet in flight;

development of the optimal shape and design of the projectile element of cartridges (ammunition) for hand-held small arms (creation of bullets with increased destructive power, tracers, incendiary bullets, determination of their optimal aerodynamic shape) in order to obtain additional properties based on the analysis of their practical use.

In the second half of the XX century — the beginning of the XXI century research in the field of military Affairs, wound and final (terminal) ballistics, as well as developments in the field of Aero- and thermodynamics led to the creation of new types of cartridges (ammunition), significantly different from those used previously, in particular a number of cartridges (ammunition) for special types of hand-held firearms-underwater and "silent". Reducing the caliber and weight of the cartridge, the use of the latest scientific and technical developments contributed to the creation of cartridge-free and multi-bullet unitary cartridges. Reactive bullets and cartridges with swept striking elements with increased transverse load and increased striking capacity have been developed [58, p. 27–90; 198; 228].

Currently, scientific research is underway to create cartridges (ammunition) with easily deformable bullets, bullets with a controllable damaging effect and increased penetrating (penetrating) ability. In con-

nection with the humanization of society, the so-called kinetic hand-held small firearms of limited striking ability (traumatic weapons) have become widespread, the creation of which takes into account the principles used in the historically formed design of hand-held small firearms, the design of the cartridge (ammunition) which includes a solid throwing element.

The use of hand-held small arms not only in the military, but also in the criminal environment (when committing crimes) is due to such its main qualities as the defeat of the target at a considerable range and high striking ability. Design improvements as a long-barreled and short-barreled small firearms (the appearance of multiply charged samples), as well as the possibility of concealed carry, respectively, resulted in a transformation of the crime.

On the basis of the analysis of scientific works on the theory of forensic examination and forensic ballistics, the evolution of special knowledge in the field of forensic research of cartridges (ammunition) used for shooting from small arms as a scientific direction in historical retrospect can be represented as a process consisting of the following main stages.

The first phase (XIV — the first half of XIX century) — designing simplest ways research manual rifle firearms. This period of emergence, development and perfection at the beginning of the simplest methods of study of the damaging effect of various types of shells, vystelennyh of small firearms. Thanks to the efforts of primarily military physicians, wound (terminal) ballistics is emerging as a doctrine about the regularities of the formation and morphology of a gunshot wound, the features of the study of injuries caused by the use of small arms firearms. During this period, mainly under the influence of requests of field surgery, traumatology and forensic medicine, wound ballistics arises and develops.

The second stage (the second half-the end of the XIX century) — the formation of the foundations of forensic research of hand-held small arms, ammunition to it, traces of the shot as a result of the use of achievements of medicine, natural and technical Sciences. At this time, at the junction of the border areas of knowledge, mainly ballistics and forensic medicine, begins to actively develop forensic ballistics. This period can be characterized as a stage of creation of bases of judicial ballistics in the form of complex scientific knowledge about manual small arms, unitary cartridges (ammunition), traces of their application used in

the process of police inquiry and judicial investigation at exposure of the persons who have committed crimes with its application.

The third stage (the beginning of the XX century — to the present) is the further development of forensic ballistics as a branch of forensic science. Adaptation of the newest achievements of various Sciences to the solution of problems of judicial ballistics is carried out, methodology and techniques of carrying out criminalistic and forensic experiments of manual small arms, cartridges (ammunition) to it, including definition of objective criterion of their striking action are improved. This period can be considered as a stage of development of forensic ballistics as an integral part of forensic Science.

To substantiate the conclusion about the stages of forensic research of cartridges (ammunition) used for shooting from small arms, consider this issue in more detail, including in the aspect of the Genesis and development of scientific ideas about the forensic study of these objects.

From the analysis of literary sources it follows that initially the study of traces of a shot from a small hand firearm was purely medical in nature. The first mention of a gunshot wound, recorded in chronicle sources, dates back to August 2, 1445 (Brunner), according to other sources — 1444; the first mention of a special tool for feeling a bullet in a wound belongs to the surgeon Pfolspeund (Pfolspeund) and refers to 1460 [186, p. 17].

In the first medical study of bullet wounds man in Russia, dated 1644, it was stated: "...Dr. Wendelinus Sibilant, Egan Belov, artman of Graman went to the Embassy courtyard and examined the deceased Prince, his obuwie wounds, and he was probably injured from a harquebus, wound under the right eye and doctor the wound examined, but the bullet was not found, because the wound is deep, but it was known that the hole is in the head" [205, p. 6].

In the literature it is noted that in civilian life, doctors were often involved in the investigation and the court as experts on issues related to gunshot wounds. A typical example is the examination conducted at the suggestion of the St. Petersburg criminal chamber and the Medical Council Ni Pirogov in criminal cases of the death of retired Colonel P. Yakubinsky (1846), the infliction of gunshot wounds to the Austrian subject Ignatius Saltzman (1853), the deliberate murder of a peasant Stepanida Nagibina (1873), etc. [211, p. 6]. N. I. Pirogov noted that the analysis of the impact on the body of "various properties of weapons and

especially wounding shells" is the main thing in determining the "properties of wounds, mortality and success of treatment…" [205, p. 193].

A. V. Nake in the book "Forensic Chemistry" (1874) attempted to summarize the empirical material on the study of small arms and traces of its use, highlighting the three stages of forensic ballistic research: a) expert examination; b) research; c) the answer to the question. In addition, he justified the need for the use of technical means during the examination of firearms, as well as the method of determining the prescription of a shot from a hand-held small firearm on the traces of a shot on the barrier and its parts [175, pp. 91–94].

In the work of forensic physician N. N. Shcheglov "Material for Forensic Research of Gunshot Injuries" (1879), the types of hand-held small arms and throwing elements, as well as the processes occurring when fired, are considered. In addition to reflecting the medical aspects of the examination, the author justified the point of view that the expert has no right to solve issues that are beyond his competence. Thus, in relation to the case of the need to identify the alleged weapon of the crime and the wounding projectile extracted from the corpse, it is noted that "such a question, as having no relation to medicine, should be rejected by the doctor and left to the decision of people knowledgeable and experienced in the arms business" [293, p. 55].

The well-known Belarusian legal scholar V. D. Spasovich also drew attention to the importance of taking into account the expert's opinion in the judicial evaluation of evidence: "When the investigation of the fact of a crime raises such questions, the solution of which requires special technical knowledge and experience in science, art, craft, the criminal court, due to its lack of competence, resorts to techniques, people…" [238, p. 104].

In the late XIX — early XX century. there were the first theoretical works on the study of the damaging effect of bullets of small arms firearms on the human body, which belonged to representatives of military and medical science and were based not only on the analysis of wounds received as a result of hostilities, but also on the results of experimental studies. The publication of the military doctor A. S. Tauber stated that "there is a need in peacetime to study the mechanism of action of firearms, to always be ready to deal with their disastrous impact on the human body" [252, p. 1]. This statement is confirmed by the experiments of the famous Russian gunsmith V. G. Fedorov, conducted in 1911–1913

on horses and cadaver material, during which, in particular, such criteria for the damaging ability of bullets of cartridges (ammunition) of hand-held small arms, sufficient to defeat the target, as the value of the kinetic energy of the bullet and the length of the wound channel were established [272, pp. 142–144].

Researchers, mainly in the field of military science, began to deal with the questions of lethal action of bullets of hand small firearms at the end of the XIX century. This was due to two main reasons: the transition to a hand-held small arms with a reduced caliber and the use of two-element shell bullets of a pointed (oval) shape for firing. Thus, N. P. Potocki in his work "Modern hand weapons: their properties, device and use" (1904) noted that in the human body only the defeat of some organs causes more or less rapid death: it is a wound to the heart, brain or spinal cord, large blood vessels, abdominal cavity; the contour of these organs occupies 25 percent of the front surface of the human body. In addition, 15 percent of the body is occupied by organs, the damage of which is accompanied by severe consequences; wounds, accounting for the remaining 60 percent of the body area, more or less light, "... their painfulness may depend on a greater or lesser deformation of the bullet, the characteristics of the nervous organization, the state of excitement of the wounded; it is impossible"; "the destructive effect of modern bullets on living targets can be considered more than sufficient: at all distances at which shooting has sufficient accuracy, bullets can disable people and horses" [55, p. 462].

The author mentions cases of recovery of individuals with through wounds of the skull and chest, as well as the results of the use of firearms by the British army during the Chitral expedition (1895). It was surprising that many Indians and horses wounded during the attack, did not fall immediately, and retained the ability to active actions "only wounds in the head and stomach were fatal, and some wounded with two or three bullet wounds could go about 10–12 miles" [55, p. 462].

The gradual reduction of the caliber of hand-held small arms, the use of cartridges (ammunition) with smokeless powder and bullets of two-element design for firing from it necessitated the scientific substantiation of the criteria for assessing their striking action. Taking into account the results of the combat use of this type of bullets in cartridges (ammunition) of hand-held small arms in England, new types of bullets of two-element design with a cut shell were tested, including bullets

with a core protruding from the shell. Due to the fragility of the shell, when such bullets hit not only the hard but also the soft tissues of the human body, they easily deformed, acquiring a mushroom shape, and thus entailed significant damage to organs and wounds.

Experiments related to the study of the lethal effect of bullets with a weakened shell were conducted in the Russian Empire. Shooting was done in both tethered and moving horses at various distances with full and reduced charges. N. P. Potocki noted that "although bullets with weakened shells and produce wounds of large size, it is difficult to heal, due to the jamming of foreign bodies in them, but such lesions do not so increase blood loss and do not so weaken the wounded that it was worth their introduction; on the other hand, such bullets significantly lose in accuracy and action on solid objects" [55, p. 460].

The described observations concerning the use of easily deformable bullets are confirmed by the modern practice of using these bullets during hunting for medium and large game (boar, deer, elk). So, easily deformable bullets can be used for injury to vital structures of the animal body (skull, heart, spine). Only damage to such organs and wounds provides instant "killing" action, and, for example, with penetrating and through wounds of the abdomen, the injured animal does not lose the ability to move and active defense.

In a result conducted in Russia a special Commission in 1911– 1913 devolving experiences on assessing damaging actions Japanese rifle patrons (ammunition) caliber 6.5 mm established, that for guaranteed destruction human or animal (horse) wounding round in moment destruction goal should possess kinetic energy 80–100 J, under this significant differences in action bullets caliber 7.62 mm and 6.5 mm on goals not revealed [270, pp. 104–121]. A. A. Blagonravov, referring to the results of experimental shooting published by V. G. Fedorov, did not offer his own definition of the term "lethal action", limiting himself to pointing out the lack of elaboration of this issue and the variety of factors characterizing this property [21, pp. 18–24].

The point of view expressed by S. S. Girgolav, according to which the human body reacts to a gunshot wound in a variety of ways, seems justified. This author pointed out that this is due to the different reaction of biological wounds to the effect of the wounding projectile, depending on a number of factors: "when the projectile passes through the brain, enclosed in a dense skull, the destruction of wounds is completely

different than when the projectile passes through the air-containing lung wounds. In view of this still N. I. Pirogov came to conclusion, that "action on organic tissue case until indefinitely variously" [186, p. 19].

In connection with the reduction of the caliber of cartridges (ammunition) and hand-held small arms to 7–9 mm, as well as taking into account the results of its combat use in the early XX century experts began to note the low efficiency of shell bullets at close range. This property was due to two factors: the oval shape of the bullet, which is characterized by a minimum transfer of kinetic energy of the target at the time of its defeat; the lack of deformation, unlike previously used bullets made entirely of lead. Eliminate these shortcomings became possible thanks to the use of bullets in cartridges (ammunition) with a blunted tip and some increase in their diameter when used in the design of cartridges (ammunition) used for firing pistols and revolvers. This made it possible to provide a sufficient level of kinetic energy transferred to the target as a result of increasing the inhibitory effect of biological wounds at the time of injury. This damaging factor was called stopping action This damaging factor was called *stopping action*.

In the literature, the following characteristics of the considered damaging factor are given "the ability of the bullet to most quickly upset the vital functions of the organism, immediately (here and further highlighted by us. — *E. L.*) depriving the enemy of the opportunity to own their weapons and the ability to further resistance" [89, p. 13]; "the ability of a bullet when hitting a living target instantly upset functions of the body, depriving the enemy the ability to further resistance" [54, pp. 113–114]; "…the ability to immediately incapacitate living targets" [23, p. 21]; it is noted the importance of "...to have a weapon that could instantly *completely paralyze* the enemy, even when hit in such parts of the body, the defeat of which is not an immediate danger to life" [75, p. 25].

It seems that the statements about the obligation of immediate (instantaneous, absolute) immobilization of the target are debatable for the following reasons:

the area of projections of vital organs on the surface of the human body, damage which entails the onset of instant death, as noted above, is relatively small;

the infliction of severe and significant damage in terms of volume without injury to vital organs (multi-comminuted fractures of the bones

of the skeleton, complete or partial separation of the limbs, etc.) is not an obstacle to the provision of active resistance;

the nature of the phase of traumatic shock. In the case of traumatic shock (under certain conditions, it can develop as a complication of a gunshot injury) caused by a gunshot wound, the victim in the first (erectile) phase comes motor excitation with the lack of adequate assessment of both his own condition and the environment. This is due to the protective reaction of the body to the injury, resulting in the blood, in addition to hormones such as adrenaline and norepinephrine, receives endorphin, which significantly reduces the reaction to pain [40, pp. 118–124; 206, p. 71].

Along with the data on the effect of bullets of hand-held small arms on the vital organs of man, scientists also studied data on injuries of the limbs (during the great Patriotic war, they accounted for at least 70 percent of injuries associated with damage to the bones of the skeleton) [186, p. 21]. A. V. Smolyannikov gives information that when wounds caused by bullets and shrapnel, which had significant kinetic energy, at close range (shots at point-blank range), the bones were crushed into many small fragments with the complete destruction of the limb and its separation; at the same time, with increasing kinetic energy, the damage zone and intensity increased [187, p. 170]. The work of M. B. Shvyrkov, G. I. Burenkov and V. R. Demenkov contains similar information obtained on the basis of the study of gunshot wounds of servicemen during the Afghan war (1979–1989) [287, pp. 17–26].

In this regard, at present, the development of new types of cartridges (ammunition) at industrial enterprises is carried out, including with the involvement of medical professionals who assess the damaging effect of bullets of cartridges (ammunition) on a person based on the severity of injuries not only of soft tissues, but also injuries of tubular bones, namely, the number of the most severe multi-comminuted fractures and the length of cracks in the bones [58, p. 147].

However, information on injuries resulting from the use of hand-held firearms during hostilities, confirm the conclusion that the concept of “stopping action” in gunshot wounds associated with severe injuries or traumatic separation of even two limbs of the body, is relative [279; 280].

The stated allows to agree with A. A. Blagonravov’s point of view that such striking characteristics of bullets of cartridges (ammunition)

of manual small arms as killing and stopping action, have subjective character, do not give in to any objective assessment expressed in quantitative indicators [21, pp.18–20; 195]. A similar position is held by E. I. Stashenko, who points out that the data on the results of the use of hand-held firearms do not always serve as a sufficient scientific justification for the conclusion about the damaging effect of bullets, and therefore can not be taken in the process of forensic activities. The study of such properties in each case is carried out, as a rule, by means of experimental studies, the reproduction of which in the conditions of expert units is difficult or impossible [245].

By the end of the XIX century in Europe began the formation of criminology as an independent science, the development of which was due primarily to the increase in theoretical knowledge in the natural Sciences, the invention of photography, etc. However, it should be noted that during this period, forensic knowledge was fragmented and did not have a systemic nature.

Thus, the founders of Forensic Science G. gross included in his book "Guide to the investigation of crimes" section on the study of hand-held firearms. This section presents information about the types of hand-held firearms, design elements of cartridges (ammunition), types of throwing elements; reveals the features of expert examination of hand-held firearms, traces of a shot, etc. [51, pp. 62–69].

In 1911, by order of the Minister of justice of the Russian Empire, senior legal adviser S. N. Tregubov and a number of other representatives of this Ministry were sent to Switzerland "to familiarize themselves with the recently established and continuing its further development of a curious branch of criminal procedure law-criminal technique" [263, p. 4], which was taught by the doctor of chemistry Professor R. A. Reiss at the special criminal Department of the faculty of law of the University of Lausanne.

S. N. Tregubov in 1915 noted that "only recently in Western Europe the attention of scientists has been drawn to the study of the improvement of investigative production by applying scientific and technical methods to the investigation of crimes and to the formulation of all branches of forensic examination on a strictly scientific basis" [263, p. 8]. Tregubov's book "Scientific Technique of Crime Investigation" (1912), written on the basis of lectures by R. A. Reis, became one of the first forensic textbooks published in Russian. In the work "Funda-

mentals of Criminal Technology: Scientific and Technical Methods of Investigation of Crimes" (1915) S. N. Tregubov first introduced the term "criminal technology", which later became (with some clarification) the name of one of the sections of Criminology. It sets out recommendations for the study of including hand-held small arms, ammunition (ammunition) to it, the elements of their design, the possibility of identifying a particular instance of hand-held small arms by its traces on bullets and cartridges, as well as describes the method of obtaining experimental samples [211].

In 1912–1914 in St. Petersburg, Moscow, Kiev and Odessa were established parlours of scientific and forensic examination (existed until 1917). After the October revolution on March 1 1919 the Parlour of forensic examination of the Central Investigation Department was created. For carrying out forensic examinations and inspection of places of incidents on the most difficult cases, including those related to the use of small arms, a Scientific and Technical Parlour was formed in the structure of the said institution [177, p. 392].

A significant influence on the process of development and improvement of forensic ballistics had studies of hand-held small arms, ammunition (ammunition) to it, traces of a shot from it, conducted abroad. In the United States, due to the increase in the number of crimes committed with the use of such weapons, full-scale collections of hand-held small arms (both American and European production) began to be created; methods for obtaining comparative samples of bullets and cartridges were improved. The result of this work was the invention in 1925 by F. O. Gravel of the comparative microscope, in the eyepiece of the prismatic nozzle of which it became possible to visually compare two objects of study simultaneously [211].

As for Soviet science, the undoubted merit in the formation of the domestic forensic ballistic examination belongs to the forensic physician and criminalist V. F. Chervakov, chief forensic expert of the people's Commissariat of health of the BSSR and the first organizer of the forensic medical service in the health system of the BSSR. In 1933 V. F. Chervakov headed the Belarusian research Institute of forensic medical examination and criminalistics [85].

In the book "Forensic Ballistics" (1937) V. F. Chervakov for the first time in the domestic forensic literature introduced the term "forensic ballistics", borrowed from the works of foreign authors. At the same

time in forensic ballistics these scientists were allocated the following sections: 1) the study of material parts of manual small arms firearms, patrons (ammunition); 2) carrying out identification researches of manual small arms firearms on the traces displayed on bullets and cartridges; 3) the study of gunpowder and other explosives, as well as methods for determining traces of gunpowder and other substances on clothing and other items that are evidence; 4) criminalistic and forensic examination of gunshot wounds [282, p. 5].

In addition, V. F. Chervyakov describes the design and practical application of water bullet catcher for experimental samples, describes in detail the mechanism of action of projectiles; the analysis of factors affecting the striking ability of bullets [282, pp. 88, 132–134].

In the Soviet period, a significant contribution to the study of issues related to the examination of cartridges (ammunition), the identification of hand-held firearms on the traces displayed on the design elements of cartridges (ammunition) to it, made V. S. Akhanov [9], V. F. Gushchin [53], I. A. Dvoryansky [60], B. M. Ermolenko [69], B. M. Komarinets [99, 100], Yu. M. Kubitsky [115], S. D. Kustanovich [119], A. N. Samonchik [240], L. F. Savran [232], E. I. Stashenko [79], E. N. Tikhonov [258], A. I. Ustinov [267], etc.

These scientists formulated the basic principles of the forensic doctrine of cartridges (ammunition) used for shooting from small arms, from the point of view of forensic science, proposed scientifically based classification of these objects, considered the methodology of their expert research. In particular, the criteria for determining the damaging ability of bullets on the basis of empirical data and methods developed by A. I. Ustinov (1968) [267] and L. F. Savran (1979) [232] are used in expert institutions and currently in the study of small arms, ammunition (ammunition) to it.

The problem of determining the minimum level of destructive power of hand-held small arms and ammunition (ammunition) to it by Soviet forensic scientists began to be actively investigated in the 1960s and 1970s. At the same time, we emphasize that the complexity of this problem in relation to forensic science, in particular forensic ballistics, is to determine the lower limit of the biological target's defeatability, and not the level of guaranteed defeat, which is used in military science [269, p. 9]. Appears to be the correct position L. B. Ozeretskovskaya, E. K. Gumanenko, V. V. Boyarintseva who believe that under the criteri-

on of the damaging effect, you should understand the empirical relationship between the parameters of the damaging factor hurting shell, for certain values which, in interaction with the biological goal is achieved given effect defeat [184, p. 241].

Forensic scientists justified the importance of accurately determining the danger boundary of the projectile, which was due to the need to solve diagnostic problems in the framework of expert research of homemade hand-held small arms. In particular, S. D. Kustanovich stated the point of view, according to which an improvised firing device can be classified as a firearm only if it is capable of hitting a projectile. Under the possibility of defeat, the author considered the presence of such a striking action, in which the bullet penetrates into the pine Board to a depth of at least 5 mm when shooting from a distance of 1 m [120].

B. N. Ermolenko was one of the first noted the dependence of the penetrating wound shells with equal speed on their diameter, therefore to define the boundaries of danger, according to the scientist, it is necessary to proceed not only from the magnitude of the kinetic energy of a hurting shell, but his penetrating ability, which can be installed through the joint efforts of criminologists and forensic [67, p. 39–42].

This approach was reflected in the experiment conducted in 1967 by A. I. Ustinov, and in the methodology developed by L. V. Savran on the basis of the results obtained during this experiment to determine the minimum lethal force of standard and atypical firearms and ammunition [232; 267].

In more detail the issues of determining the objective criterion for assessing the damaging ability of the wounding projectile from the point of view of forensic science are set out in section 3.4 of Chapter 3 of this work.

Since the 1990th, the development of theoretical provisions and practical developments in the field of forensic ballistic examination has been most active in the Russian Federation. This trend was due to a number of objective reasons: the growth of organized crime, the presence of large enterprises for the manufacture of firearms, local military conflicts, a significant number of illegal firearms in the population, etc. Problematic issues of production of forensic ballistic examinations of cartridges (ammunition) used for shooting from hand-held firearms are covered in the works of Russian scientists A. G. Egorov [248], A. V. Kokin [95; 98], S. M. Kolotushkin [93], I. V. Latyshov [146] O. V. Miklyaeva

[167, pp. 78–79], V. A. Ruchkin [235], M. A. Sonis [237], A. V. Stalmakhov [248], V. A. Fedorenko [269] etc.

The development of Belarusian forensic ballistics was promoted by scientific developments of such scientists as A.V. Dulov [65], G. N. Mukhin [173], A.V. Lapin [122], V. M. Logvin [156], and practitioners-A. A. Artyushin, A. G. Kunitsky, V. V. Pototsky, V. G. Shavel, etc.

However until recently forensic ballistics lacked a comprehensive scientific approach to the problem under consideration. Aspects of forensic research of cartridges (ammunition) used for shooting from small arms as independent objects of research are devoted only to separate scientific works [202; 31; 229; 237; 258; 303]. It should be noted that most of these works are more of applied importance, they are more or less affected by the issues of methodological support of examinations of cartridges (ammunition) used for shooting from small arms, characterized by a debatable nature.

In addition, the need to improve the efficiency of methodological support for forensic research of these objects is due to the following factors:

incompleteness of the process of systematization and theorization of a significant amount of disparate knowledge accumulated by forensic ballistics, in relation to the issues of forensic research of cartridges (ammunition) used for shooting from small arms firearms;

ambiguous understanding of the terms and their definitions used in the production of forensic ballistic examinations, not only by the staff of expert units, but also by other interested parties due to their inconsistency with the terms and their definitions enshrined in normative legal acts, including technical normative legal acts that regulate issues related to hand-held small arms, ammunition (ammunition) used for shooting. This problem has been addressed in the publications of both domestic [73; 152] and foreign scientists [108; 147; 237];

the emergence of new, previously unknown species patrons (ammunition).

Proceeding from the above, we believe that the further development of special knowledge in the field of forensic research of cartridges (ammunition) used for shooting from small arms, should be carried out by conducting more in-depth scientific research of applied orientation, the introduction of private methods for solving specific expert tasks.

Consolidation in the methods of expert research of such General methodological provisions as terms and their definitions, criteria for attribution of cartridges of small arms to the category of "ammunition" , etc., will provide a stable theoretical basis in terms of forensic research of these objects of forensic ballistic examination.

Thus, we will make the following generalized conclusions:

1. The emergence and improvement of the design manual of small firearms, as well as the reasons for the transition to use for firing him unitary of the rounds (ammunition) identified in the analysis of literature on various branches of knowledge, due to the progressive processes of scientific and technological progress, which are the continuity and evolutionary nature, as well as the specific conditions of combat use in certain historical periods.

2. The transition from weapons, which used muscle power to small firearms, which used energy of powder gases due to the presence of the latter is the new, characteristic-specific properties (large range, striking ability, the ability to automatically reload while shooting, easy in operation, etc.). In further some principles functioning of and elements design manual rifle firearms extended on other species (pneumatic, barrel gas), that evidence suggests continuity approaches to designing weapons.

3. The use of small arms as a weapon of crime, which in turn led to the need to study its properties by persons with special knowledge in the resolution of criminal cases, was the reason for the allocation of forensic ballistics as an independent branch of knowledge. The initial forensic ballistic studies of hand-held firearms were carried out by forensic physicians, since their practical experience allowed to judge the processes caused by a wounding projectile when it hits the human body, which led to the study of these specialists of the device of hand-held firearms, cartridges (ammunition) used in it for shooting, traces of a shot and shooting. Expanding the scope of theoretical knowledge in the study of these objects made it possible to form a clearer idea of the manual small arms, ammunition (ammunition) to it, to develop the classification of these objects in relation to the tasks of forensic science.

4. Special knowledge in the field of forensic research of cartridges (ammunition) used for shooting from small-arms firearms is currently at the stage of systematization and theorization of the results of expert practice, on the basis of which new knowledge is synthesized. Formation of practice of expert research of the specified objects, as a rule,

is limited to the corresponding type (subspecies) of forensic expert research that predetermined development of a considerable number of private techniques of criminalistic research of the cartridges (ammunition) used for firing from manual small arms firearms.

5. The development of special knowledge in the process of forensic research of cartridges (ammunition) used for shooting from small arms, actualizes the need to develop a unified methodological framework, including the creation of a unified conceptual and categorical apparatus, the study of the laws of improving the design of cartridges(ammunition), its individual elements and their impact on the process of forensic research, the establishment of scientifically based criteria for assigning these objects to the category of "ammunition", determining the suitability of the studied objects for shooting. In addition, need a more in-depth study of a number of issues relating to the use of special knowledge for the classification of cartridges of small arms (firearms) to the category of "ammunition", in particular the definition of the subject, object, tasks of their examination, systematization of methods of this type of expert research, development and implementation in practice of new methods of obtaining objective information about the nature of the phenomena inherent in these objects.